

**GOVERNMENT REVIEW  
OF THE  
COUNTDOWN COMPANIES  
1992 ACID GAS EMISSIONS AUDITS**

**JANUARY 1995**



**Ministry of  
Environment  
and Energy**



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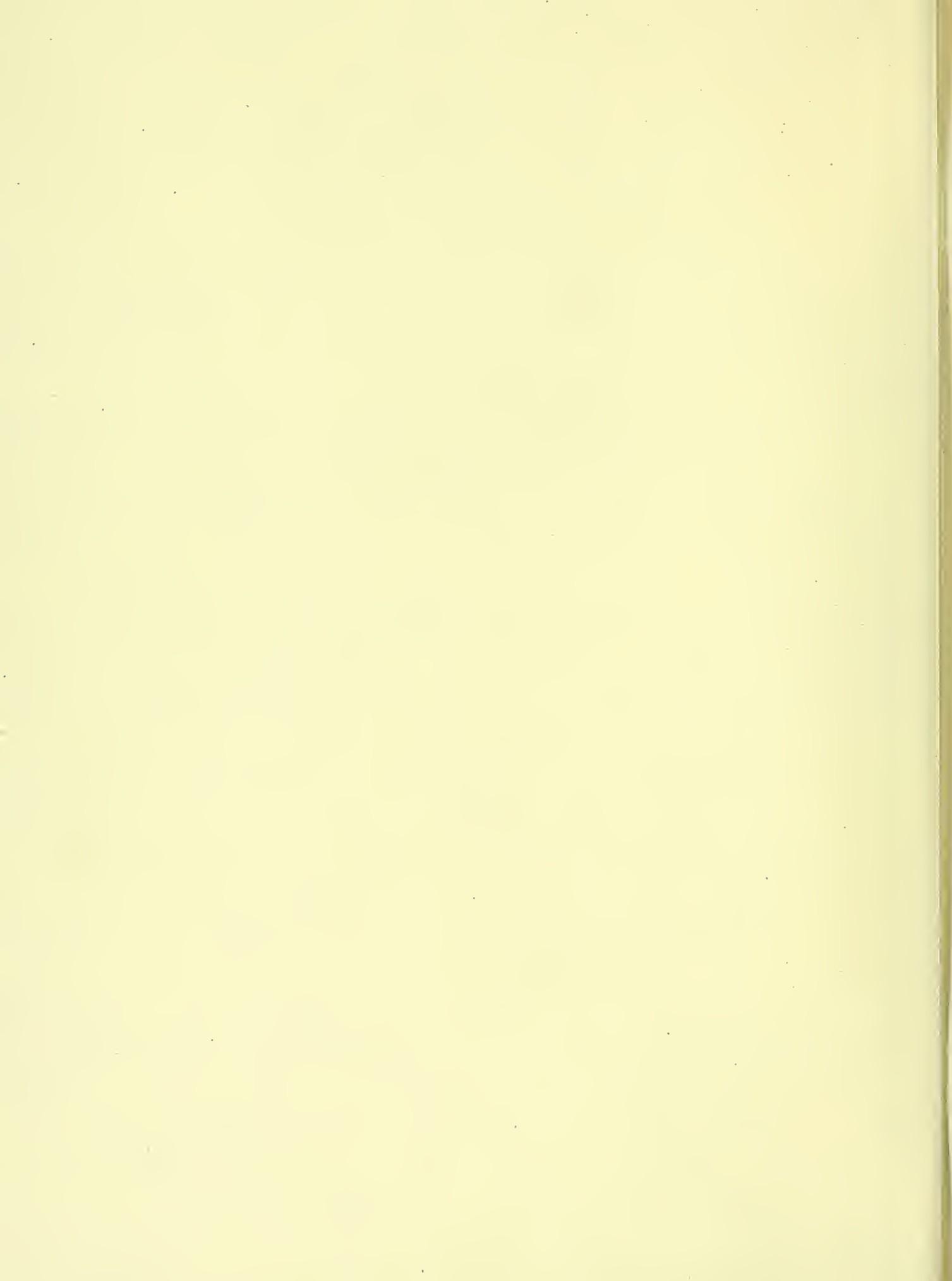
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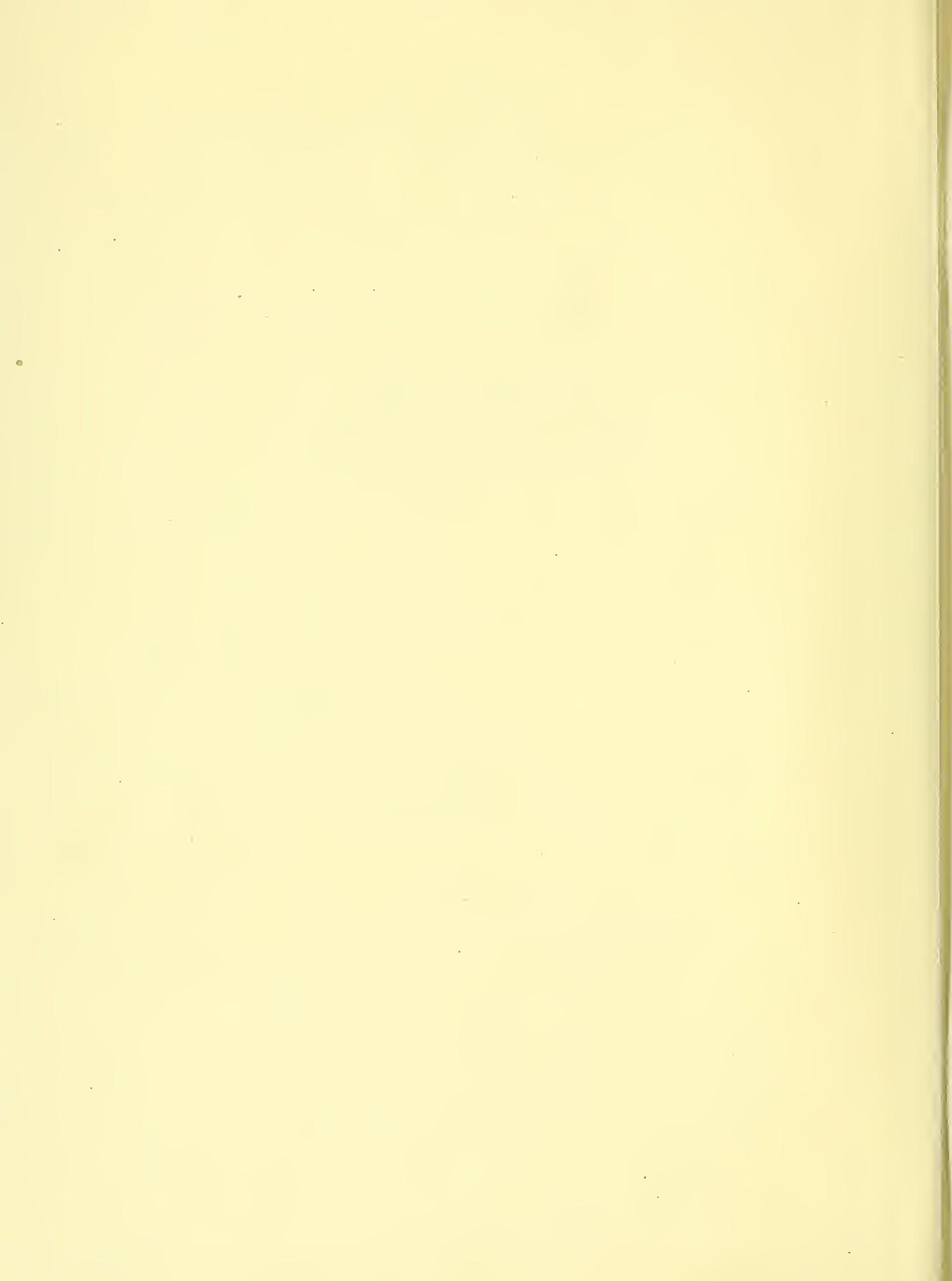
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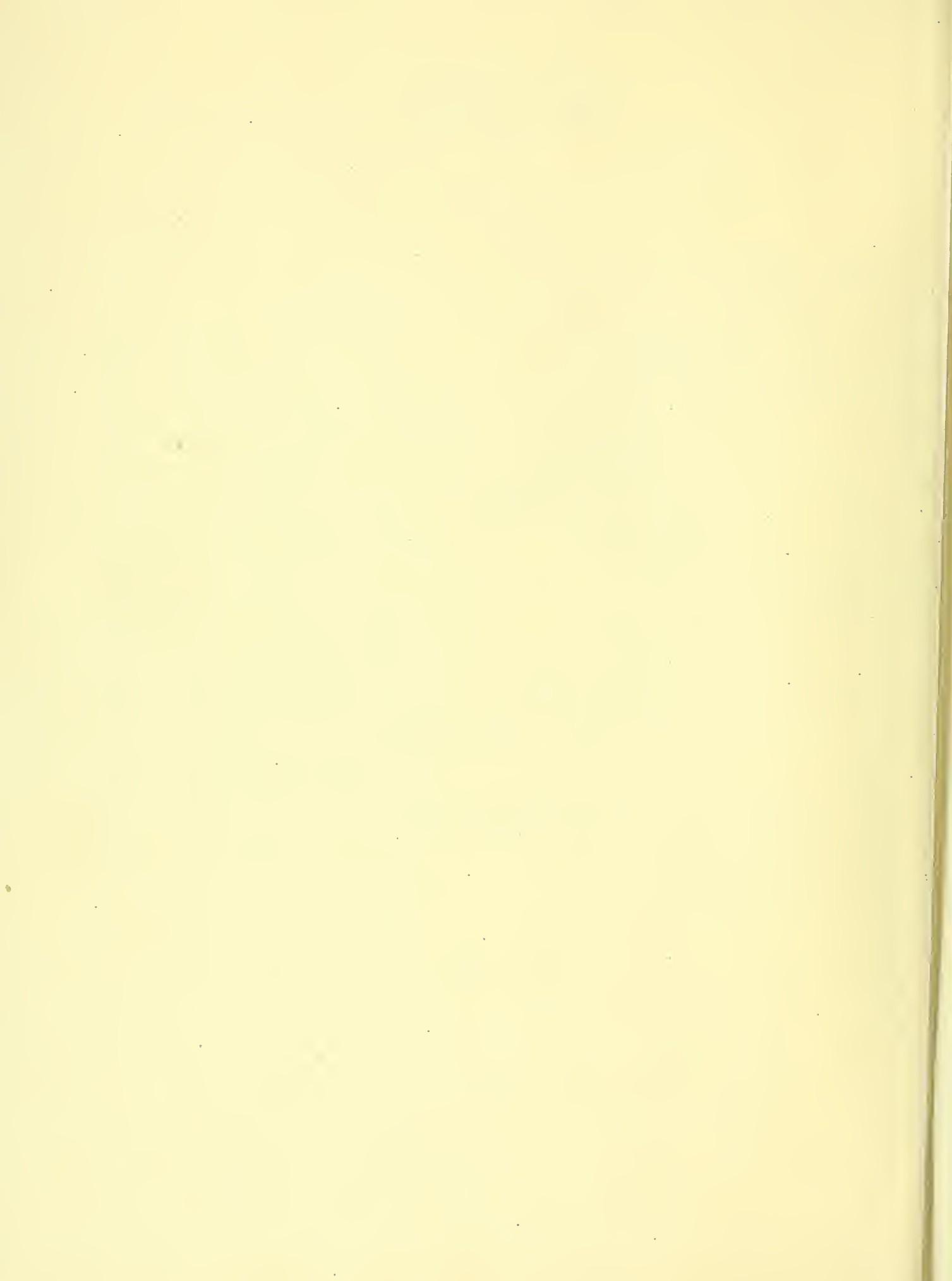
**GOVERNMENT REVIEW  
OF THE COUNTDOWN COMPANIES  
1992 ACID GAS EMISSIONS AUDITS**

Report Prepared By:  
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Ontario Ministry of Environment and Energy



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## EXECUTIVE SUMMARY

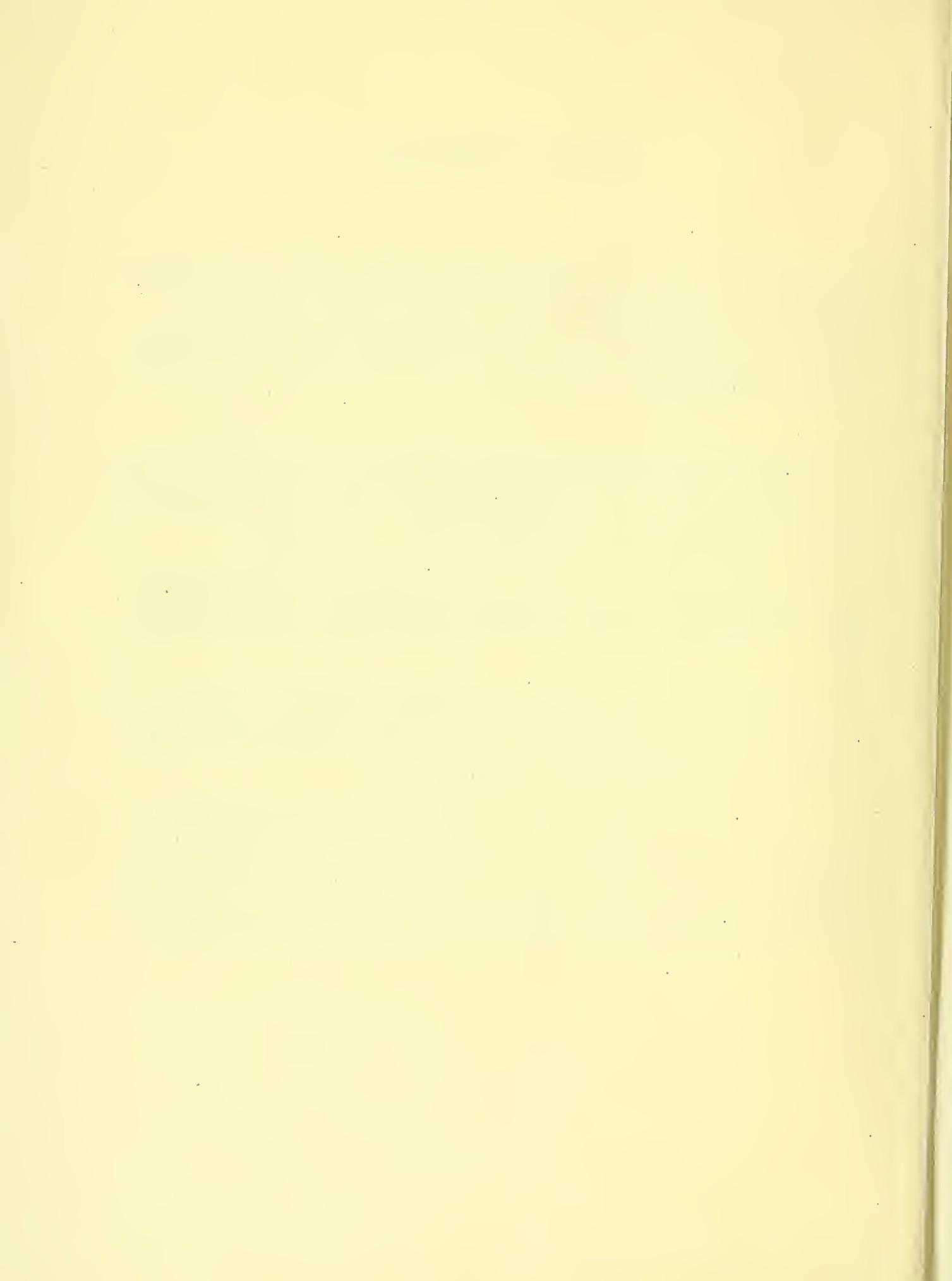
This report summarizes environmental audits of the four major Countdown Acid Rain emitters for sulphur dioxide ( $\text{SO}_2$ ) and nitric oxide (NO) in the Province of Ontario for 1992. This verification program was applied to three metallurgical companies: INCO Limited, Falconbridge Limited and Algoma Steel Inc. (Wawa Operations), and to Ontario Hydro's fossil fuel fired generating plants. These four major emitters are regulated under Ontario's Countdown Acid Rain Regulations and by Director's Orders under Section 18, *Environmental Protection Act R.S.O. 1990*.

The auditor verified that the INCO Limited  $\text{SO}_2$  emissions of 416 kt for 1992 were calculated using previously accepted and described procedures and records. Minor deviations and observations not described in the sulphur mass balance manual, did not substantially affect the reported emission quantities. Recommendations were also provided to improve the procedures and hence to increase the reliability and accuracy of the emissions.

Falconbridge Limited reported 54 kt of  $\text{SO}_2$  emissions for 1992 from their Falconbridge smelter operation. Due to the auditor's inability to properly verify the hourly roaster feed tonnages, the uncertainty of the emissions increased from an initial estimate of  $\pm 4.7\%$  to  $\pm 5.1\%$ .

Algoma reported 36 kt of  $\text{SO}_2$  emissions for 1992 from their Wawa sinter plant. Their emissions uncertainty was determined to be  $\pm 2.1\%$ . The lower reported emission quantity, in comparison to the 1991 emissions of 53.0 kt, was due to the processing of low sulphur recyclable iron oxide materials and lower production levels.

Audits of Ontario Hydro's fossil fuel generating facilities confirmed that the reported combined annual  $\text{SO}_2$  and acid gas ( $\text{SO}_2 + \text{NO}$ ) emissions were 157 and 210 kilotonnes (kt), with an accuracy of  $\pm 3.0\%$  and  $\pm 2.4\%$ , respectively. The emissions were below the Regulation limits for 1992. Further, the auditor reported that all thermal generating stations were following the emissions mass balance method described in the procedures manual. Minor deviations noted did not affect the quantity and accuracy of the reported emissions.



## 1.0 INTRODUCTION

An acid gas emissions verification program was implemented in 1990, as part of the Countdown Acid Rain Program. This verification program was applied to four designated emitters, namely the metallurgical companies INCO Limited, Falconbridge Limited and Algoma Steel Inc. (Wawa Operations), and Ontario Hydro's fossil fuel fired generating plants. These four emitters are regulated under Ontario's Countdown Acid Rain Program Regulations, and further directed under Section 18 Director's Orders of the *Environmental Protection Act* R.S.O. 1990.

The Countdown Acid Rain program limits the acid gas emissions for the four emitters, according to the following schedule:

### ONTARIO'S COUNTDOWN ACID RAIN PROGRAM

#### ANNUAL LIMITS FOR ACID GAS EMISSIONS\* IN KILOTONNES

COMPANY	YEAR		
	1986	1992	1994 (& beyond)
INCO Limited	685	685	265
Falconbridge Ltd.	154	154	100
Algoma Steel	180	180	125
Ontario Hydro	370	240	175
	430	280	215 (SO <sub>2</sub> plus NO)

\* For SO<sub>2</sub>, except where noted otherwise.

The Director's Orders, issued under Section 18 of the *Environmental Protection Act* R.S.O. 1990, require the emitters to prepare and submit Sulphur Mass Balance Procedure Manuals, and determine the overall uncertainty of their respective annual emissions. In addition, the emitters were required to engage an independent auditor to develop an Audit Protocol Manual and conduct procedural audits of the reported emissions. The auditors were required to evaluate and comment on the sulphur mass balance (SMB) procedures used to determine

that the SO<sub>2</sub> and NO emissions reported to the Ontario Ministry of Environment and Energy. Overall, the auditors were to confirm that the reported emissions were verifiable, accurate and reliable.

The background for the emissions verification program is detailed in an earlier report entitled "Government Review of the Countdown Companies 1991 Acid Gas Emissions Audits<sup>1</sup>." This report summarizes the findings of the 1992 acid gas emission audits.

## **2.0 DIRECTOR'S ORDER REQUIREMENTS**

All four emitters were determined to be in compliance with the various requirements of their individual Orders. A summary of these requirements was provided in an earlier report<sup>1</sup>. More recent developments, since the Orders were issued in June and July of 1990, are summarized as follows:

### **2.1 INCO Limited**

INCO Limited was granted an extension until the end of 1994 to complete a study on the feasibility of using continuous emission monitoring (CEM) to report annual SO<sub>2</sub> emissions. This CEM study will not be undertaken until the smelter process changes are completed and have reached a steady-state operation.

### **2.2 Falconbridge Limited**

The company was also required to study the feasibility of using CEM to report annual SO<sub>2</sub> emissions from its smelter operations. The final study report, prepared by Hatch Associates Ltd., was submitted in December 1993 and is presently under review by Ministry staff.

### **2.3 Algoma Steel Inc. (Wawa)**

Algoma's Wawa sinter plant is in compliance with all the requirements of the Order. The SO<sub>2</sub> emissions are being reduced as the company continues to increase the processing of recyclable oxides/revert materials. These materials contain substantially less sulphur than the ore.

### **2.4 Ontario Hydro**

The Order was amended in February 1992 to provide additional time for Ontario Hydro to solve technical problems with newly installed continuous flue gas monitoring systems (FGM). At present, the accuracy of a number of these FGM systems has been validated and the remaining systems will be tested by the end of 1994. In the

interim, semi-annual acid gas emissions audits are being based on mass balance procedure methods.

### 3.0 AUDIT FINDINGS FOR 1992

The audits were conducted according to the approved audit protocol manuals to determine the degree of compliance with the sulphur mass balance procedures. The audits comprised random verification of the sampling, weighing and assaying methods and results and some checking of the computations of emissions. Statistical estimates of the uncertainty of the annual emissions were also reviewed.

The auditors confirmed that the reported emissions for 1992 from the metallurgical companies and Ontario Hydro were reliable, accurate and verifiable. They also confirmed that the 1992 emissions from the metallurgical companies were within the limits as required by their respective Ontario Regulations (Regulations 660/85, 661/85 and 663/85). In the case of Ontario Hydro, the audit also confirmed that both the SO<sub>2</sub> and NO emissions were within the limits for 1992 as required by Ontario Regulation 355/90 (formerly O. Reg. 281/87).

The following table summarizes the 1992 SO<sub>2</sub> and NO emission levels, and their associated accuracy.

#### 1992 SO<sub>2</sub> EMISSIONS IN KILOTONNES

Sources	Legal Limit Requirements	Emission Levels 1992	Accuracy ± %
INCO Limited	685	416	2.0
Falconbridge Limited	154	54	5.1
Algoma Steel Inc.(Wawa)	180	36	2.1
Ontario Hydro	(SO <sub>2</sub> ) 240	157	3.0
	(SO <sub>2</sub> +NO) 280	210	2.4

\* Accuracy was accepted after audit, however Inco is reviewing its estimation methods to include possible bias errors

### **3.1 INCO Limited**

The auditor confirmed that the 1992 SO<sub>2</sub> emissions from the Copper Cliff Smelter and Refinery operations were 416 kt. The audit revealed only minor deviations from the sulphur mass balance (SMB) SO<sub>2</sub> emissions estimating method. These deviations have been corrected and the improvements recommended by the auditor have been carried out. Further, the company is fine-tuning the method used for determining the overall uncertainty of the reported annual SO<sub>2</sub> emissions so as to incorporate possible bias errors.

#### **Highlights of the Auditor's Report:**

The auditor, Price Waterhouse<sup>(2)</sup>, confirmed that the reported SO<sub>2</sub> emissions were based on materials sampling, weighing, assaying and calculating methods described in the Procedures Manual. The auditor did not comment on the accuracy of the reported SO<sub>2</sub> emissions since the statistical analysis method had not been accepted by the Ministry at the time of the audit.

The auditor noted 23 deviations (findings) from the SMB Procedures and 5 procedures (observations) in use which were not described. The auditor also provided 11 recommendations to improve the SMB procedures and accuracy. The main deviations in mass balance procedures recorded and observed are highlighted below:

- not re-certifying the matte transfer scale and estimating the matte weight during scale fault events
- not performing consistently regular full scale calibrations testing, and rigorous inspection and maintenance programs
- not undertaking a rigorous and representative sampling program for liquid SO<sub>2</sub>, matte, copper/nickel concentrate and dumped slag
- not undertaking consistently proper sample preparation and compositing for dumped slag, copper sulphide (MK) and matte materials
- not using consistently the Thompson Manitoba smelter matte weights
- not using updated LECO furnace sulphur assay standards and assaying techniques
- not undertaking weekly Nusonic assaying of acid control samples
- not documenting consistently the copper/nickel assays in the master list file

The auditor noted that the following procedures in use were not described in the manual:

- not documenting the comparison of sulphuric acid assays from samples collected at different locations
- not documenting the control process for sulphuric acid weights and reconciling shipments
- not using the improved procedure for determining acid and oleum strengths by the Nusonic analyzer
- not documenting fully the control information surrounding the listing, filing and recording of the copper/nickel assays

The major recommendations of auditor's report for improving the existing procedures are mentioned below:

- upgrading the matte transfer scale recording ticket system
- eliminating the duplication of preparing sulphur product shipment summaries
- using a standard weight (check every six months) to perform calibration tests on the Park Road and Anode scales
- establishing a new preventative maintenance, calibration testing schedule and logging system for the scales
- using skimmer dumped slag pot counts to provide the most reliable weight and maintaining records for two years
- documenting the sampling period to ensure that timely and representative samples are obtained
- providing the Bessemer slurry sulphur content, as another known quantity, to ensure that the Metal Flow and Costing (MFC) accounting is accurate
- documenting routine maintenance of the LECO instrument in a log book and being consistent with the task analysis approved method

## **Government Review of the SO<sub>2</sub> Emissions Audit**

INCO's 1992 SO<sub>2</sub> emissions of 416 kt were about 39% below the limit of 685 kt set for the period 1986-1993. In addition, the emissions are approximately 57% above the limit of 265 kt set for 1994 by Regulation 660/85. Statistically, the SO<sub>2</sub> emissions were estimated to have an uncertainty of  $\pm 2.0\%$ . The company is expected to meet the emission limit requirements for 1994 through smelter process changes and full commissioning of its new acid plant, scheduled for completion by November 1993. The Procedures Manual will be revised accordingly to include a description of the new smelting process and acid plant operations.

### **3.2 Falconbridge Limited**

The auditor has verified that the reported 1992 SO<sub>2</sub> emissions were 54.2 kt, with an overall uncertainty of  $\pm 5.1\%$ , at the 95% confidence level. The auditor was unable to verify the roaster feed hourly tonnage using the recorded data for selective auditing periods. A subsequent investigation revealed that the instantaneous feed rate was used instead of the hourly average feed rate. In addition, several minor deviations of the SMB procedures were noted, based on the procedures described in the Procedures Manual. A number of recommendations were provided to address these deviations.

#### **Highlights of the Auditor's Report:**

The initial audit and subsequent investigation by Hatch Associates Ltd.<sup>(3)</sup> confirmed that the SO<sub>2</sub> emissions of 54.2 kt reported by Falconbridge Limited for 1992, were based on the procedures described in the procedures manual. From a follow-up investigation of roaster feed rate data, the uncertainty of the 1992 emissions was increased from  $\pm 4.69\%$  to  $\pm 5.1\%$ .

The recommendations to address the deviations from the SMB procedures are summarized as follows:

- the concentrate feed tank drop test and slurry density determination procedures be improved; all roaster feed data calculation be recorded and only the average hourly roaster feed data be used; and adjustment to the feed percentage solids and roaster feed analysis results outside of the control limits be recorded
- rail and truck custom feed scale calibrations be kept in the Custom Feed Office
- results of weekly belt-cutting coke sample be recorded in the CCR logbook

- matte scale calibration records and assays outside of the control points be kept in the custom feed office
- sulphuric acid sampling be undertaken according to the SMB procedures
- converter slag cleaning (CSC) - slag control quality XRF spectrometer testing be based on CSC standards, range checking for input into the smelter balance be modified and actions to verify the unaccountable gains greater than 2% be documented
- the most current weak acid effluent analysis procedure be used
- memos, correspondence, reconciliation notes affecting the SMB be identified and kept in the SMB plant office file

#### **Government Review of 1992 SO<sub>2</sub> Emissions Audit**

The procedures audit by Hatch Associates Ltd. confirmed that the 1992 SO<sub>2</sub> emissions of 54.2 kt were in compliance with Regulation 661/85. These emissions are about 65% less than the 1992 limit of 154 kt and 46% below the 1994 limit of 100 kt.

The company has agreed that the deviations noted in the 1992 SO<sub>2</sub> emissions procedures will be corrected or improved, with particular emphasis on roaster feed and acid weight determinations, before the next audit.

#### **3.3 Algoma Steel Inc. (WAWA OPERATIONS)**

The auditor confirmed that the company's reported 1992 SO<sub>2</sub> emissions of 36 kt were accurate within  $\pm 2.1\%$  of the calculated value, at the 95% confidence level. The improvements recommended by the auditor will be carried out before the next audit.

##### **Highlights of the Auditor's Report:**

The audit by Rowswell and Associates Engineers Ltd.<sup>(4)</sup> confirmed that there were no major deviations noted from the Procedures Manual.

The company continues to develop a Quality Assurance and Quality Control (QA/QC) program for assaying sulphur in both the blended ore and sinter using LECO and X-ray spectrometer methods. The QA/QC program for the sinter is being implemented.

The auditor noted that the reliability and accuracy of the SO<sub>2</sub> emissions can be further improved by:

- i) maintaining the tracking alignment of the main ore, oxide and limestone feed belt (T-14) and associated weigh scale
- ii) undertaking frequent calibration testing of the scales

#### **Government Review of 1992 SO<sub>2</sub> Emissions Audit**

The auditor confirmed that the reported 1992 SO<sub>2</sub> emissions of 36 kt were in compliance with Regulation 663/85. This emission estimate is about 80% less than the limit of 180 kt for the period 1990-1993 and 71% lower than the limit of 125 kt set for 1994.

The main blended ore feed conveyor belt (T-14) was re-aligned and calibrated 22 times during the year. Rigorous maintenance and frequent calibration testing of the T-14 belt has substantially reduced the uncertainty in the SO<sub>2</sub> emissions.

#### **3.4 ONTARIO HYDRO**

The 1992 audit confirmed that the reported SO<sub>2</sub> emissions of 157 kt were accurate to within  $\pm 3.0\%$  and the NO emissions of 53 kt were accurate to within  $\pm 3.9\%$ . The total acid gas emissions (SO<sub>2</sub> plus NO) of 210 kt were accurate to within  $\pm 2.4\%$ . The SO<sub>2</sub> and acid gas emissions were audited for each quarter of 1992.

The NO versus load curves estimating method for four units (Nanticoke 2 units, Lambton and Lakeview 1 unit each) were updated in 1992. There were no major deviations from the Procedures Manual.

#### **Highlights of the Auditor's Report:**

Angus Environmental Ltd.<sup>(5)</sup> conducted quarterly SO<sub>2</sub> and total acid gas (SO<sub>2</sub> and NO) emissions audits of the fossil fuel generating plants. In addition, diesel generators serving remote communities and standby combustion turbines at both fossil fuel and nuclear generating plants were also audited for each quarter in 1992. The uncertainty for the quarterly SO<sub>2</sub>, NO and total acid gas emissions ranged from 3.4% to 9.4%, 7.0% to 8.3% and 3.0% to 7.2%, respectively. The total acid gas emissions were determined to be the most accurate. In the third and fourth quarter audits of the 1992 emissions, the uncertainty in the SO<sub>2</sub> emissions was higher than for the corresponding NO emissions.

The auditor verified that the SO<sub>2</sub> and total acid gas emissions for the year 1992 were calculated according to the procedures described in the manual. No major deviations

of the procedures were noted. In addition, the accuracy of SO<sub>2</sub> and NO emission estimates were statistically evaluated for reliability.

The auditor confirmed that 98.96% of SO<sub>2</sub> and 96.10% of the NO 1992 emissions resulted from coal fuel combustion generation. Comparison of the old with updated NO versus load curves indicated that the NO emissions could be underestimated by about 8.0%, for selected units.

The auditor recommended the following:

- developing a program to improve station laboratories reproducibility for coal sulphur analysis, according to ASTM D-3177-89 requirements
- conducting regular fly ash analysis for calculating the actual sulphur retention factor
- using the actual fuel oil products sulphur content or CGSB specifications
- eliminating the potential bias error of underestimate NO emissions by updating the NO versus load curves
- developing an electronic emissions data handling procedure to avoid transcribing errors
- taking into account emissions related to SO<sub>2</sub> usage for flue gas conditioning

All except the following recommendations provided in the 1991 audit reports have been implemented by Hydro:

- annual determination of retention of sulphur in ash
- electronic data transfer from stations to head office
- annual updating of NO vs. load curves; a separate agreement has been worked out to solve this problem

#### **Government Review of 1992 Acid Gas Emissions Audit**

Ontario Hydro's 1992 SO<sub>2</sub> and acid gas emissions of 157 kt and 210 kt were in compliance with Regulation 355/90 requirements. These emission levels were approximately 35% and 25% below the limits set for 1992, and 16% and 2.3% below 1994 limits, respectively.

The reported uncertainty of  $\pm 3.0\%$  and  $\pm 2.4\%$  in 1992 for SO<sub>2</sub> and acid gas (SO<sub>2</sub> plus NO) emissions, respectively, were acceptable.

The NO versus load curves for all operating boilers must be updated to facilitate the auditor's verification of the NO emissions accuracies. These load curve updates are to be completed before end of 1994.

#### **4.0 Overall Comments on Acid Gas Emissions Audits:**

Since establishing the audit program in 1990, the major acid gas emitters have improved the accuracy and reliability of the reported annual emissions, and standardized their emissions estimating procedures. The third party independent audits have provided increased acceptance and credibility of the reported emissions.

The Ministry considers these auditing programs necessary to verify the accuracy and reliability of the reported emissions. Reporting accurate SO<sub>2</sub> and NO emissions is also necessary to meet the Provincial Government Auditor's requirements and Federal/Provincial agreements (accord signed by seven provinces east of Saskatchewan/Manitoba border in 1987). The March 1991 Canada/United States Air Quality Accord, further requires accurate SO<sub>2</sub> emissions estimates for each Province in Canada. Auditing programs are also required to substantiate the acid gas emissions quantities, as stricter and reduced annual emission limits are imposed. The need for a verifiable emissions program is important if Ontario and other Provinces adopt a program similar to the United States SO<sub>2</sub> emissions trading system.

#### **5.0 SOURCES OF INFORMATION**

1. Government Review of the Countdown Companies Acid Gas Emissions Audit (1991).
2. INCO Limited - Ontario Division: SO<sub>2</sub> Emissions Procedural Audit Report for the year ended December 1992 by Price Waterhouse ( 1993).
3. Audit of Reported SO<sub>2</sub> Emissions from the Falconbridge Smelter for 1992 by Hatch Associates Ltd. (1993).
4. Audit of Annual SO<sub>2</sub> Emissions for the year 1992 for Algoma Steel Inc. Algoma Ore Division (Wawa, Ontario) by Rowswell and Associates Engineers Ltd.(1993).
5. Procedural Audit of Ontario Hydro's Measurement Methodology for Acid Gas Emission Estimates for Fourth Quarter 1992 and for 1992 annual emissions by Angus Environmental Ltd.(1993).



